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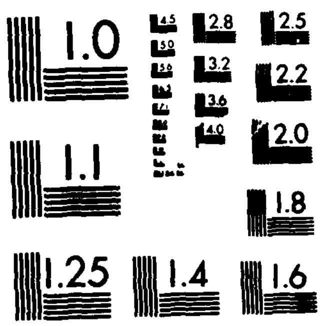

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This report offers guidance in recognizing, investigating and abating indoor air problems. Current published literature concerning indoor air quality was reviewed and combined with USAFOEHL field experience to provide a logic trail the base BEE could follow while doing a sick building survey. In addition, this guide can also serve as a handy reference for indoor air quality standards, sampling techniques and questions concerning possible sick buildings.

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CONTENTS

I. INTRODUCTION

A. This guide's purpose is to assist the base BEE in recognizing, investigating and abating an indoor air quality problem. Because of the highly emotional nature of some of these situations, the complexity of the buildings, and the fact that environmental monitoring may be inconclusive, the investigation of indoor air quality problems can be difficult. Therefore, the approach to such a nebulous problem requires defined objectives in logical order. This report intends to provide such guidance.

B. While Bioenvironmental Engineers (BEEs) are well equipped to recognize, measure and evaluate occupational exposures to traditional physical and chemical hazards, most BEEs, until recently, have not been called on to monitor non-industrial environments. Some modern office buildings, hospitals and sometimes even homes, once commonly considered to be free of overt health hazards, are now being recognized as possible unhealthy environments for the occupants. Due to the tight, energy efficient design of modern buildings, and energy conscious modifications to older buildings, the indoor air quality may degrade, resulting in the surfacing of otherwise hidden problems. This phenomena is known as Sick Building Syndrome (SBS).

C. The scope of this report was to review and summarize the existing published literature concerning indoor air quality and combine it with USAFOEHL experience to provide a logic trail the base BEE could follow while performing a SBS survey. This report should be adaptable to environments either commonplace, or uniquely Air Force. This guide can also serve as a handy reference for indoor air quality standards, sampling techniques and questions concerning possible sick buildings.

II. SIGNS AND SYMPTOMS

A. SBS is characterized by a significant number of building occupants complaining of nonspecific symptoms. The most common complaints can be one or several of the following:[1]

eye, nose and throat irritation
head and bodyache
fatigue or drowsiness
sneezing and sinus congestion
problems wearing contact lense
dry, discolored, or itching skin

Other specific complaints may occur; it's too hot, too cold, too dry, or there is an odor. A collective consciousness is emerging among air quality managers and health care providers; that the occupants' perception of the building's impact on their health is closely related to the ambient humidity, temperature and other comfort parameters.[2]

B. It's important to note that in most cases, the occupant's discomfort increases as the day progresses and relief comes upon leaving the building. SBS sufferers have reported dramatic improvement in their condition after

being out of the building for a short time and a relapse upon re-entering the building. This is especially obvious over the weekend break.

C. The BEE may get involved in a SBS problem in a number of ways; phone inquiries, medical referrals, or even as a SBS affected occupant. Whatever the way, quick follow-up is paramount. SBS may occur as an episode dependent on transient conditions such as weather, ambient pollen counts, and events happening inside the building.

III. INITIAL ACTIONS

A. Once a SBS problem is suspected, it is best first to characterize the symptoms and complaints. The Environmental Health Office (EHO) and the Flight Surgeon's Office (FSO) must be involved. Objective historical and physical data should be obtained. Physical examinations, interviews and health questionnaires must be used to substantiate complaints, localize the problem areas and calculate attack rates. Health questionnaires are sometimes useful. The EHO should be the one who administers a health questionnaire of his or her design, or use the one included with this report as Appendix A. Use questionnaires only if individual interviews will be conducted with the respondents. Only after analyzing the diagnostic data can the presence or absence of a health problem be defined and the building be implicated as the cause of the health problem.

B. Colonel Bruce J. Poitrast, the Occupational Physician at USAFOEHL, outlines the physician's role in a SBS investigation and addresses the phenomena of reaction to aggravated irritants and perceptions. Dr Poitrast's interesting and thought provoking paper is included as Appendix B of this report.

C. Be aware that a few outspoken occupants do not necessarily make a sick building. You can judge indoor ambient air to be acceptable and yet it will still be objectionable to four out of 20 people at any one time.[3] A normally ventilated building can have up to a 20% complaint background noise level.[2] However, don't discount the localized complaints, there still may be a micro-climate comfort problem, or a perception problem.

IV. BUILDING INSPECTION

A. After implicating the building with medical expertise, the next step is a thorough inspection of the building. Inspection efforts should be well defined, objective and focused on one particular aspect of the building at a time, such as tracing an odor or following a dust trail. Much time can be wasted by nonspecific walk-throughs. If the problem is localized, the medical data will indicate the area where the inspection should concentrate. Otherwise, the BEE should concentrate on prioritized factors that have high probability of causing SBS.

B. The first aspect of an inspection is to look for an obvious cause of the complaints. The SBS cause may not be truly SBS in nature, but a simple and overlooked contamination source recently introduced, or an otherwise

routine process malfunctioning. Some common agents and problems of this nature are:

1. Ozone can be emitted from many copy machines and may accumulate if ventilation and maintenance are neglected.[4]

2. Methanol is released from spirit duplicators in proportion to its content in the duplicating fluid. It has happened in the past that previously methanol-free duplicating fluid has been unknowingly restocked with fluid containing methanol.

3. Unreported spills of strong cleaning fluids or laboratory stock can cause problems, especially if the vapors are transported by the ventilation system.

4. Step outside to see if a contamination source, such as a misplaced dumpster is affecting the building's fresh air intake.

5. Office improvements often can introduce vapors and dust from construction, glues, carpets, wallboards and new furnishings.

C. Don't underestimate cigarette smoke as a cause of complaints and related health problems. AFR 30-27, Smoking in Air Force Facilities, governs indoor smoking. This regulation prohibits smoking in areas with less than 10 cubic feet of fresh air per minute per person (cfm/person) and certain other locations such as elevators and auditoriums. In general work areas, this regulation delegates the majority of smoking control to local management. Commanders and supervisors are directed to allow or limit smoking based on local conditions. Many times the BEE is called to render advice and expertise when the commander is faced with a sensitive smoking issue.

The 22 July 86 interim message change to AFR 30-27, supports the objectives of the DOD Directive 1010.10, 11 Mar 86, "to create a social environment that supports abstinence and discourages use of tobacco products."[5] This message mandates that commanders decide any smoking dispute in favor of the nonsmoker.

D. If no obvious source of contamination is found, the next step in a SBS investigation is to survey the heating, ventilation, and air conditioning system, (HVAC).

V. VENTILATION SURVEY AND EVALUATION

A. Indoor air quality, as dictated by the HVAC set-up, is the most important consideration when investigating a true SBS problem. Numerous sick building syndrome investigators have reported that SBS occurs more frequently when the HVAC has been tampered with, contaminated, failed, or ventilation rates are maintained below or near the minimum recommended standards.[6,7,8] A HVAC system survey should consist of three phases:

1. First is the HVAC system review. Understanding how the manual and automatic system controls operate is essential in order to evaluate the HVAC performance. Get the system schematics and other drawings, and go over them

with the Heating and Refrigeration people, and the building's mechanical engineer and maintenance personnel. Be sure to find out about any HVAC system changes, modifications, or problems.

2. Next is the HVAC system inspection. Look for problems and document the conditions.

a. Record the temperatures and relative humidities (RH) throughout the building and outdoors. The RH should be 50 ± 5% and the temperature should be 72 ± 4 degrees F.

b. Note what type, how many and the condition of the HVAC filters. There normally will be pre-filters and micro-trap filters in the larger HVAC systems.

c. Check the outside air dampers to be sure they operate as designed. Jammed dampers, bird nest blockage and dampers wired shut for energy conservation will reduce the available fresh air. In one investigation, even though the design mechanical engineer called for a particular damper setting and the HVAC maintenance technician stated another, upon inspection the actual damper setting was 100% recirculation.[9]

d. Look for excessive moisture, pooled water and organic growths, especially in air conditioners and humidifiers. Biofouling could lead to inferior HVAC performance and, even worse, microbial contamination of the recirculated air.

e. See if the outside air inlet is influenced by a source of contamination such as a building exhaust stack, a downwind industrial process, construction, or vehicle exhaust. The proximity of the building to a flight line, any truck loading ramp, auto parking or idling areas, and other potential contaminant sources can influence the outside air quality.

3. If the HVAC review and inspection hasn't identified the SBS cause, the last phase is to measure the air flows and do mass balances. Supply air volumes in areas or rooms indicate area air changes. Building inlet and exhaust air volumes indicate building air changes and the percent of outside air being brought in. Measuring exhaust air volumes usually are more effort than the data are worth, but in certain situations it may indicate the 'tightness' of the room, area, or building.

B. Air Force Standards: The AFM 88-15, Criteria and Standards for Air Force Construction, states that mechanical ventilation systems shall be designed, installed and protected in accordance with the American Society of Heating, Refrigerating & Air Conditioning Engineers (ASHRAE) recommended practices. In addition, AFM 88-15 offers some standard fresh air rates for indoor ventilation. In Table 6-1 of AFM 88-15, the outside air infusion rates are 5 cfm/person working in air conditioned offices, 10 cfm/person in interior offices during winter and 3 cfm per square foot of mechanically ventilated office during summer.[10]

Section J of AFM 88-15 gives very specific requirements for the environmental conditions inside medical and dental facilities. Design requirements specific to functional areas cover air supply, room pressure, temperature and humidity.

C. ASHRAE provides ventilation system design and operational standards, as well as minimum fresh outside air requirements. ASHRAE 62-73, "Indoor Ventilation Standards" was published in 1977 and has been used since then to design the ventilation systems in many of the buildings constructed in the last decade. For a typical office setting, this standard recommends a minimum of 5 cfm, or 2.5 liter per second (l/s) of outside air (OA) per person. Also recommended are other ventilation rates for various living and working spaces. ASHRAE modifies and increases their recommended ventilation rates where smoking is permitted.[11]

1. Fresh supply air is not necessarily considered outside air by ASHRAE. Exhaust air from one space can be used as supply air to another space where different contaminates are generated. An example of this air use would be office air supplied to a toilet room before being exhausted.[3]

2. ASHRAE has recently updated the 62-73 standard with its ASHRAE R62-1981, "Ventilation for Acceptable Indoor Air Quality." This standard still recommends the same minimum outside air per person, and offers an alternative approach to indoor air quality. Similar to industrial hygiene, this approach sets the outside air infusion rate, usually between 10 to 20 percent of the total recirculated air, then determines if this make-up air rate is adequate based on contamination monitoring. Carbon dioxide (CO_2) is the best indicator or marker gas when determining the fresh air make-up rates. For general ventilation standards, ASHRAE recommends a limit value of 0.1%, or 1000 ppm CO_2 in the building's air.[2,3] Increasing the building's intake of fresh outside air, which usually has a CO_2 content around 300 ppm, is the most effective way of lowering the inside CO_2 concentration.

D. A detailed ventilation survey of every air duct, supply grill and return louver is very labor intensive and in most cases not necessary. Measuring the building's main air exchange rate and some of the representative problem rooms or areas will usually supply enough data for an evaluation. Comparing representative ventilation data to the design specifications will tell you if the system is performing properly or needs balancing.

E. If after the HVAC system has been evaluated and determined to be functioning properly, yet the SBS persists; try increasing the fresh air intake before you go any further. Increasing the amount of fresh outside air infusion usually raises the quality of inside air and abates the SBS problem, but not always. If there is a contamination source affecting the building air inlet, or if the HVAC is at fault itself, the problem will persist.

VI. AIR MONITORING

A. New and old HVAC systems can leak combustion and flue products into their supply side. Cold season start-ups can circulate accumulated dust and fugitive off-gasses. HVAC systems that are damp and moisture prone may harbor and circulate biological hazards such as bacteria, viruses and fungi. Inadequate HVAC filter efficiency, or poor filter maintenance can contribute to the circulation of dust, fibers, molds and pollen. These and other factors that influence the indoor air quality can be accurately assessed by doing air monitoring.

B. The National Institute for Occupational Safety and Health (NIOSH) dispatches field teams composed of a mechanical engineer, an industrial hygienist and an occupational physician to investigate sick buildings. In over 600 surveys, they usually found that traditional industrial hygiene sampling efforts proved inconclusive. Currently, NIOSH limits air monitoring to a few marker gasses and vapors. They sample for one, or a variety of air contaminants only when circumstances warrant it and when strong suspicions indicate that a specific agent(s) may be present.[12]

C. Marker gasses

1. Monitoring for marker gasses is the most useful technique when evaluating indoor air quality and should always be done first. Measuring the gasses carbon dioxide and carbon monoxide will indicate if sufficient amounts of outside air are being supplied to the building, or if there are areas of stagnation that accumulate respiratory gases and tobacco smoke.

2. Carbon dioxide (CO_2) concentrations are normally less than 600 ppm and correspond linearly to the amount of people per unit of volume. The classic example of insufficient outside air being supplied to the building is when the morning ambient CO_2 concentration of 250-300 ppm climbs steadily until noon, remisses slightly during lunch and then continues to climb the rest of the work day. Overly 'tight' buildings with normal populations can easily triple their CO_2 levels by noon.

3. NIOSH presented the following empirical carbon dioxide concentrations as their guide when determining the quality of indoor air:[12]

CO2 Levels, ppm	Occupant's Response
< 600	ideal
600-800	Some complaints if the room temperature is elevated
800-1000	Expect more complaints
> 1000	General complaining, consider increasing fresh make-up air

4. Carbon monoxide (CO) is another useful marker gas when evaluating the indoor air quality. Indoor CO levels usually average 1.0 ppm or less in a properly ventilated building where moderate smoking takes place. NIOSH and ASHRAE guidance cites 5 ppm or less of CO in the indoor air as acceptable.[3,12]

5. Elevated indoor CO levels are most always generated by cigarette smoking and will rise relative to the amount of smoking taking place. However, CO contamination can be caused by improperly vented heaters and other sources. Close proximity to a roadway or flightline, may influence the indoor CO concentration with peaks at rush hours.

6. Remember, the CO_2 and CO concentrations of 600 and 5 ppm, respectively, are not in themselves harmful, but are markers that quantitatively indicate indoor air quality.

C. Dust

Particulates generated during facility improvement, or from neglected HVAC may cause SBS. Total and respirable dust samples can be taken with high volume or personnel samplers. Fiber counts for fugitive fiberglass can also be done. The American Conference of Governmental Industrial Hygienists (ACGIH) standard for exposure to nuisance dust is 5 mg/m^3 but irritation can occur at concentrations less than this, especially for more sensitive office, or hospital occupants.[20] Computer printers can generate paper dust that gives rise to the fictitious 'paper mites' that bother some workers. Since the results of most particulate samples taken in a office environment will be less than the occupational limits, their usefulness is limited to a qualitative interpretation of the area's relative cleanliness.

D. Chemicals

1. If you have strong suspicions of the presence of possible vapor or gas contaminants, low range colorimetric indicator tubes can be used for some of the more common ones such as, carbon monoxide, carbon dioxide, ozone, ammonia, chlorine, nitrogen dioxide, perchloroethylene, methanol and hydrocarbons. Other sampling is done for formaldehyde when occupants complain about mucous membrane irrition. Sodium dodecyl sulfate, an ingredient in many carpet shampoos has also been associated with mucous membrane irritation in certain offices.[13,14] Other possible contaminants can be collected in accordance with the USAFOEHL Sampling Guide and sent to USAFOEHL/SA for analysis. It's usually not very productive to pull a grab sample with a charcoal tube, or an air bag and send the sample in for 'discovery' analysis. There are many reasons for this; i.e., the sample volume is too small for trace analysis, or the sampled contaminants require dissimilar methods of analysis.

2. A MIRAN infrared analyzer is handy for monitoring the marker gases CO and CO_2, and for measuring the concentrations of many other suspected specific vapors. However, its scanning function is of limited help in this type of investigation because of the difficulty in interpreting minute differences in the resulting infrared spectra.

3. ASHRAE Std 62-1981, (Table 2) lists 28 materials with ambient air quality guidelines. Most of the substances listed have 24 hour exposure limits which in many cases may best apply to building inhabitants. A commonly voiced rule of thumb is that one tenth of an Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL) or ACGIH Time Weighted Average (TWA) is an acceptable general population exposure.[3,15] However, sound professional judgment must be used when modifying standards.

4. Don't be disappointed if the concentrations of the identified contaminants are so low as to defy interpretation. In numerous SBS investigations, measured concentrations were 100 to 1000 times lower than the appropriate workplace standard.[10,11] However, the number of the different chemical species identified, sometimes over 30, suggest some association with the building occupants' complaints. To make some sense out of sample results which show a collection of contaminants, of which none are outstanding enough to suggest a source, and all are well below the TLVs and odor thresholds, try changing the building ventilation in some way. Then a sometime useful data inference might be made if there is a change or lessening in the contaminant mix.

E. Biological Aerosols

1. SBS can be caused by excessive moisture in the HVAC system, producing elevated populations of biologic aerosols that can cause hypersensitivity pneumonitis and other respiratory reactions.[8] There also exists the concern, sometimes bordering on hysteria, that Legionella bacteria can contaminate the HVAC, especially cooling towers, and cause Legionnaires' disease.[12] It's best to avoid evaluating microbial contamination and HVAC biofouling, but if it is present, sampling can be done to quantitatively and qualitatively assess the microbial air burden.

2. Equipment used to sample for bacteria, molds and fungi is similar to that used in industrial hygiene. The air sampling principles for collecting viable and nonviable biological particles are the same as used for industrial particles, 50 microns and less. Sedimentation, filtration, impingement in a liquid, impaction onto a solid surface, centrifugation, and electrical and thermal precipitation can be used depending on the properties of the particles being sampled.[16] The only real difference between sampling for viable particles and industrial particles is the need to nurture the collected sample. In most cases, a liquid or a gel agar is the collection media.

3. At USAFOEHL/ECH, we have two types of specialized samplers:

a. Scientific Products TDL slit-to-agar impactor. This sampler rotates an agar plate under a precision slit at variable speeds and a fixed air flow rate of 1 cfm. Once sampled, the agar plate is then incubated and the specific viable organisms can be identified and a total colony count obtained. One particular advantage of this type of sampler is that it reflects the variations in the concentration of organisms over the period of time it takes to rotate the agar plate. We have a developed protocol for using this sampler.[17]

b. Anderson 2000 cascading impactor. This sampler is the standard sampling device used for measuring viable aerosols and is very similar to the particle size discriminating impactor used for industrial sampling, but instead of greased plates at each stage there is an agar plate. The particular advantage of this sampler is that it segregates the organisms into six aerodynamic size ranges. While six size separation is useful for certain research applications, for SBS purposes only the simple separation of respirable and nonrespirable is needed. The particles collected on stages 1 and 2 are considered to be nonrespirable and the others respirable.

4. Glass bubblers, midget impingers and spill-proof personal impingers can be used with liquid agar. However, they have a basic characteristic of breaking up the clumps of organisms and the cultured result is a much higher total colony count per cubic foot of air. Other less dynamic forms of sampling include swabbing and culturing of suspect contamination areas such as HVAC filters and condensation trays, and setting out agar settling plates. Passive plate sampling is not representative because of its bias towards heavier particles, but it is helpful when used in conjunction with dynamic samplers to act as a control against sampler contamination.

5. When sampling for microorganisms, the services of a microbiologist and a mycology laboratory are needed. Most hospital labs can culture, identify and count the majority of biological species sampled. These laboratories can usually supply the nutrients needed for the collection media. In the event there is a suspected biological agent causing the SBS, find out what kind of support can be enlisted from local hospitals, clinics, laboratories and state health departments. Many medical facilities have biological sampling procedures already established for biologic aerosol control in operatories and supply rooms. If more assistance is needed, contact USAFOEHL/ECH at AV 240-3214 and we can help with advice, sampling methods and equipment.

6. With the exception of hospitals and other sterile areas, there are no standards and little guidance on hazardous concentrations of biological aerosols. Much of this is due to the possibility of sensitization and the extreme variableness of human response to the different species, both viable and nonviable. There is little doubt that the exposures farmers receive during harvest can manifest symptoms. These levels can be as high as 50,000,000 organisms/m^3 of air.[18] Harvest levels are many magnitudes higher than ambient levels of 5000-7000 microorganisms/m^3 found in a typical rural environment. Yet, current thinking on indoor microbial concentrations indicates total colony counts in excess of 10,000 microorganisms/m^3 and 500 colonies/m^3 for any one species is unacceptable.[8]

7. The AF does not have specific policy guidance on Legionella bacteria in HVAC cooling towers, but USAFOEHL concurs with the existing recommendations of the Cooling Tower Institute, Environmental Protection Agency, Center for Disease Control and ASHRAE. These agencies recommend:[18]

a. Rigorously comply with the cooling tower manufacturer's recommended maintenance procedures.

b. Control the propagation of slime, algae and bacteria with the use of a registered general purpose microbiocide. Accumulation of bacterial slimes and similar biofouling can be considered controlled when the total bacterial plate count carried out on samples of recirculated treated water show less than 500,000 organism/ml.

c. Separate the HVAC intake and the cooling tower exhaust so cross contamination of the intake air is minimized. There are no recommended distances, nor siting configurations because there is no evidence supporting the notion that good siting alone can eliminate contamination and be considered safe.

8. If the SBS problem is the result of an elevated population of microooganisms harboring in the HVAC or the building itself, the only way to reduce their numbers is to deny them ideal growth conditions. Dehumidification, prevention of water incursion and stagnation, and the use of high efficiency (ASHRAE rated 50-70%) filters are some of the control methods.

VII. CONCLUSION

A. In summary, when you are faced with possible sick building syndrome;

1. Characterize the symptoms and complaints with temporal and spatial distribution. Utilize the services of the Flight Surgeon and the Environmental Health Offices. Heed Dr Poitrast's insight (Appendix B).

2. Survey the building for an obvious source of contamination. Look for recent chemical spills, malfunctioning equipment, 'special' cleaning being done, facility improvements, or renovations.

3. Survey the HVAC. Evaluate the amount of fresh air per person, make sure there is at least 10% make-up air, better yet 15 to 20%. Try increasing the fresh air intake if it seems only marginal on first evaluation.

4. Document the conditions, make sure the HVAC is operating properly. Note the inside temperature and humidity. If comfort parameters or ventilation balancing are problems, fix those before proceeding.

5. After the above have been accomplished, consider doing air sampling. Monitor the marker gases and if their levels indicate inadequate air quality, increase the fresh air intake.

6. If you strongly suspect air contamination, then sample only for the agent(s) suspected. If sampling is inconclusive and the problem persists, increase the fresh air intake.

B. Remember, in most cases, the sick building syndrome does not have a clearly understood etiology and many of the SBS studies and investigations were inconclusive. The significance of exposure to many contaminants at low levels is not clear. Whether this type of exposure can be pathogenic remains unanswered, but the realities of worker complaints and discomfort are valid

reasons to seriously address this problem. Stress can produce or trigger SBS.[21],[22] Complaints, SBS in nature, can be induced by ergonomically poor work stations, some video display terminal (VDT) clerical pools, or high stress environments. It's important not to let this type of problem escalate into hysteria, or psychosomatic symptoms. During the investigation answer any question in a honest manner and avoid speculating on the SBS cause. And if all else fails, OPEN A WINDOW!

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APPENDIX A

Office Health Questionnaire

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OFFICE HEALTH QUESTIONNAIRE

Some individuals working in this office building have registered health complaints. To help investigate the possible presence, or absence, of these complaints, this questionnaire is being distributed to all occupants. Your assistance is requested. Please complete this questionnaire as accurately as possible. Return in a sealed envelope to the building manager. Thank you for your assistance.

1. COMPLAINTS: (Select choices that may be related to your presence in this building. This is a random list--not all complaints listed have been noted in this building).

____ Aching joints
____ Muscle twitching
____ Back pain
____ Hearing disturbances
____ Dizziness
____ Dry, flaking skin
____ Discolored skin
____ Skin irritation/itching
____ Heartburn
____ Nausea
____ Noticeable odors
____ Sinus congestion
____ Sneezing
____ Chest tightness
____ Eye irritation
____ Problems wearing contact lenses
____ Headache
____ Fatigue/drowsiness
____ Temperature too hot
____ Temperature too cool
____ Other (specify) ________________

2. WHEN DO THESE COMPLAINTS OCCUR?

____ Morning
____ Afternoon
____ All day
____ Daily
____ Specify day(s) of the week
____ No noticeable trend

3. WHEN DO YOU EXPERIENCE RELIEF FROM THESE COMPLAINTS?

____

____

DO YOU HAVE ANY OF THE FOLLOWING?
(Please check positive responses)

____ Hay fever, pollen allergies
____ Skin allergies/dermatitis
____ Other allergies
____ Cold/flu
____ Sinus problems

5. DO YOU SMOKE TOBACCO?

____ Yes
____ No
____ Amount

6. ON WHAT FLOOR OF THE BUILDING ARE YOU LOCATED? ____________________
WHAT DEPARTMENT OR AREA? ____
ARE YOU NEAR ANY OFFICE EQUIPMENT? ______________________________

(Specify) ______________________

7. COMMENTS OR OBSERVATIONS:

____
____
____
____
____

NAME (optional): ______________________________

APPENDIX B

Sick Building Syndrome

A Physician's View

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Sick Building Syndrome

A PHYSICIAN'S VIEW

1. Sick Building Syndrome is one term for a phenomenon that has occurred frequently in the last ten years. Other names are: building sickness; office epidemics; and tight building syndrome.[2] It has been reported in homes, industrial buildings, schools, offices, hospitals and in the open air.[1,2,4,5] The numbers of people involved have varied from one to as many as a thousand.[4,5] People affected by this syndrome have blamed a myriad of causes including cigarette smoke, formaldehyde, war gas, unknown chemicals, and cathode ray tubes. The list of causes has recently been expanded to include the psychological.[2]

2. In approximately 40% of the cases, symptoms will be caused by agents in one of the following groups: physical agents such as grits and finely powdered coarse materials and synthetic fibers: common allergies to pollens, fungus, dander, mites and house dust: infectious disease such as legionnaires disease; and damage to bodily tissues resulting from immune responses mobilized against invading organisms. This response takes place primarily in the lung.[2]

3. In the remaining 60% of the evaluations accomplished either no apparent cause was found or inadequate ventilation was blamed. In most of these cases, a recommendation for increased ventilation resolved the problem.[2] Investigators, puzzled with such positive results from such a simple maneuver, have explained their inability to resolve these issues in terms they understand by saying they cannot measure everything, and something or a combination of things unmeasured in the air must have been at a toxic level. This attitude has led to increasing concern on the part of the public. The belief we are being sickened by unknown or low level factors has become widespread. This has led to demands for tighter environmental controls. Unfortunately tightening controls does not address the issue and the resulting lack of adequate resolution produces anxiety.

4. The physician has a key role in the investigation of sick building syndromes. In investigations of circumstances where the cause cannot be determined, the physician's role is even more vital. It is the responsibility of the physician to define illness. The direction of the investigation cannot be delineated without a definition of the disease. Without such a definition, it is impossible to know when or if resolution of the problem has been reached. In order to define the disease it is necessary to interview and examine the persons affected.

5. Investigators unfamiliar with the use of questionnaires should avoid the temptation to send out a generalized questionnaire. Effective use of questionnaires is difficult at best. Poor questionnaires lend virtually nothing to the resolution of the problem. Poorly administered or generalized questionnaires contribute to the confusion by giving the appearance of extracting specific data while in fact gathering general symptoms whose temporal and spatial distribution cannot be adequately judged and applied to the problem. An adequate interview includes a complete medical history and pertinent physical examination. It may be that there are too many subjects to

interview with available resources. In these circumstances, a representative sample must be interviewed. Once this is accomplished, a definition of the illness in terms of signs and symptoms can be established.

6. Not infrequently the information gathered will define many diseases which were active at different times of the year in different parts of the building. As previously mentioned, seasonal hayfever and allergies to specific mold and bacteria can produce symptoms such as cough, bronchitis, sore throat, fatigue, burning and itching eyes and throat, and rhinorrhea. These may be incorrectly attributed to the building because of the heightened concern that the building occupants have regarding their health. If there is a residual problem which is related to being in the building, and it is shared by a significant number of people at the same time, and it is relieved by leaving the building then a problem can be said to exist within the building. In almost all instances the symptoms will be of an irritative nature. At this point one must keep in mind the psychological climate in the building.

7. Minor symptoms of irritation may become a cause of major concern in an environment where communication is poor and stress is high. Stress may be high due to poor employee-management relations or poor ergonomics. The cause of many irritative symptoms has been traced to inadequate comfort ventilation and uncomfortably low relative humidity. Inadequate ventilation has increased in the past ten years because of energy considerations. Many new buildings are designed with narrow, unopening windows and air conditioning ventilating systems which add only 10% fresh outside air every hour. Not surprisingly the air has a tendency to become stale and dry. Irritative symptoms result from increased levels of everything from body odor through perfume to smoke. The irritative response to these substances is heightened by uncomfortably dry relative humidity. As the day progresses the temperature may rise within the building and cause a sensation of stuffiness. The natural tendency to open a window in such an environment is frustrated by building design. This leads to tension and complaints to building managers. Managers check to see that the air conditioning ventilating system is working properly. It usually is. Announcements to this effect don't stop the complaints. Soon an adversarial situation has arisen between occupants and a seemingly deaf or helpless management. Air samples do not show toxic levels of any substance. This leads to either the "hidden toxin" concept or the belief that harmless levels of substances are in fact harmful. At this juncture symptoms of anxiety begin to appear in the occupants.

8. Unfortunately, the symptoms of anxiety center in the respiratory and cardiovascular systems.[6,7] Breathing rates increase in spite of the lack of physical exertion. This often leads to a full-blown hyperventilation syndrome, with symptoms of choking, breathlessness, lightheadedness, dizziness, weakness, numbness and panic. The sensation of the heart racing may lead to fears of heart attack. More panic may ensue and, not infrequently, those observing the phenomenon become affected themselves. Absolute panic has been known to occur in such situations ending with a mass exodus from the area of concern.[1,3]

9. A more objective look at the situation will usually reveal CO_2 levels which rise steadily throughout the day in the building. Normal outside levels are about 300 parts per million. Most people begin to feel stuffy when CO_2 levels reach 600 to 800 parts per million. Almost everyone expresses discomfort between

800 and 1000 parts per million. This is not because these levels are toxic, they are not. The CO_2 level is an indicator that the air is stale and that irritating substances are causing irritation, not toxicity. It is the unexplained irritation in combination with the anxiety symptoms that is the "agent" provoking the problem. The symptoms most commonly reported in NIOSH investigations of mass psychogenic illness are the very ones most frequently reported in association with low levels of irritating substances such as formaldehyde: headache; dizziness; nausea; dry mouth and throat; eye, nose and throat irritation; sleepiness and drowsiness; weakness; numbness and tingling; chest tightness and discomfort.[3] These are also the symptoms of hyperventilation with anxiety. The reason that symptoms disappear in the majority when the ventilation is increased is because the irritation disappears and something positive has been done. A positive action on management's part is a sign to the building occupants that they have been heard. This by itself will relieve tension. The dramatic response to increased ventilation is much more comprehensible when viewed in the perspective of the total human being. In addition, no "hidden" or unlikely causes need be invoked to explain the problem and people can be assured of problem resolution.

10. In summary then, it is the physician's responsibility to define what constitutes a case in terms of signs and symptoms. As part of this definition, temporal and spatial distribution in the building must be delineated. Without these steps adequate resolution of the difficulty cannot be obtained. Without adequate physician to patient contact, lingering doubt will almost always remain, as to the actual cause of the problem.

11. The statement in the foregoing paragraph with regard to physicians is in no way meant to denigrate the contribution of industrial hygienists, health officers and technicians to the resolution of these problems. It is made to clarify what the physicians role in the investigation actually should be. The loss of the contribution of any one of the investigators in this process will as readily lead to inadequate resolution as the lack of the physicians contribution.

Addendum

As this document was undergoing final review, References 1 and 2 of the addendum bibliography were published in the February 1987, Journal of Occupational Medicine. The Wharton et al article is an excellent example of exactly the problem discussed here. The Guidotti et al brief communication expands meaningfully on Reference 1 of the original bibliography.

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2. Wharton, M.D., L.R. Larson, M.J. Gordon and R.W. Morgan; Investigation and Work-up of Tight Building Syndrome. J. Occ. Med., 1987, 29:142-147

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